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A Preliminary survey for mosses in nurseries of Mosul city with new record of three species

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ABSTRACT

The collection and study of Bryophyte plants in Mesopotamia began in the 16th century AD through the expeditions that flourished at that time. Since that time up to 2025, all published works, on this plant group, were limited to the country's natural ecosystems, while man-made ecosystems were completely neglected. This was the motivation behind directing our efforts toward artificial or man-made ecosystems and conduct a preliminary survey for the species inhabiting them, in order to supplement the available information about them. The present contribution is considered the first survey in Iraq related with the mosses of the manmade ecosystems (i.e.) the nurseries. Mosul city center was chosen for this purpose. The survey covered 7 nurseries, all located in the left side of Tigris river. The results revealed that the recorded species belong to one class of division Bryophyta, 5 orders, 6 families, 11 genera and 19 species, among them, the following three species: *Bryum muehlenbeckii* Bruch & Schimp., *Entosthodon fasicularis* (Hedwig) Müller Hal. and *Leptobryum pyriforme* (Hedw.) Wilson were considered new addition to the Iraqi bryoflora. Distribution of the species in the nurseries and the richness of each nursery with moss species were widely varied.

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1. INTRODUCTION

Collection and identification of Mesopotamian Bryophytes have been started in (16th) century, during the expeditions that have been flourished at that time, among the pioneer contributors was the German scientist Leonhard Rauwolf who visited the area between (1574-1575) as cited in Ray [1]. Since then and up to date number of works have been published by researchers from outside and inside of Iraq, however, all these publications dealt with study of the Bryophytes in their natural ecosystems only, while the artificial ecosystems have been completely excluded. The ecosystems consists of both biotic and abiotic components and their continuous interactions with each other.They can occur naturally or can be created artificially by major human modification in the natural environment. The nurseries are an artificial ecosystems, they are being raised for different purposes among them getting plants of the desired species and of the right size at the right time [2]. There is a great probability for Bryophyte to grow, accidentally, in the nurseries due to availability the high moisture, light and temperatures necessary for successful seedling production which also favor the growth of 'primitive plant' (i.e.) the Bryophytes. addition of the fertilizer will enhance significantly the favorable growing conditions and growth of these pest plant populations [3] The major source of moss contamination in the greenhouses, as mentioned by Ross & Puritch, [4], are used containers and airborne spores. The other probable source are the raw soil that are obtained from the supliers

Mosul is the city center of Nineveh province, located in the north par of Iraq and considered one of the major cities in the country. Numerous nurseries scattered within the city on both sides of Tigris river. To fill the gap in the available information, about Iraqi bryoflora, the present contribution devoted for considering mosses in artificial ecosystem, the nurseries. It is a preliminary survey aimed to know which moss species may reach, grow and thrives in the pots with ornament or seedling plants.

2. METHOD

Collection and preservation:

A total of 34 moss specimens were collected from 7 nurseries, All of them are located in the left bank of Tigris river at Mosul city, center of Nineveh province. Names and locations of the nurseries in addition to sampling dates were included in (Table 1). The moss specimens were grown on top soils of the pots with ornament plants. In the field, the upper most 1.0 cm of the soil was scraped, with a blunt knife, and placed in a newspaper envelope. Then they were numbered and the essential information about each one was recorded. In the laboratory the specimens left to dry and placed in a numbered and labeled paper envelopes. After this stage the specimens became ready for preservation and identification.

Identification:

Each specimen was first examined, under stereomicroscope model OPTO-EDU, to determine number of the species contained in it. Few individuals of each species were taken and refreshed by soaking in distilled water. A temporary slides for leaves and capsules were prepared and examined by compound microscope model OMAX with digital camera model A59.4910. Identification performed depending on the key mentioned in Smith [5] and Lawton [6]

Table 1. Names and locations of the studied nurseries in addition to the sampling dates

Names of nurseries		location	No. of specimens
Forest Department, Univ. of Mosul Official	7 may 2024	Campus of Mosul Univ., Coll. of Agriculture, Dept. of Forestry	7
Ninawa official	29 may 2024	In Al-Ghabat region	14
Artdh Al-Noor Private	5 may 2024	On the two sided street of Al-Noor residential district	2
Al-Sahm Al-Akhdar Private	5 may 2024	On the two sided street of Al-Noor residential district	2
Al Ferdaws Private	5 may 2024	On the two sided street of Al-Noor residential district	3
Al-Muhannad Private	5 may 2024	On the two sided street of Al-Noor residential district	3
Al Muthanna Private	3 June 2024	Al-Muthannah Residential district In front of Women's Health	3

3. RESULTS AND DISCUSSION

Identification of the taxa revealed that they were 19 moss species existed in the nurseries under study (Table 2).

Table 2. Synopsis of classification for the identified species according to [7]

DIVISION BRYOPHYTA Schimp.
SUPER CLASS V
CLASS BRYOPSIDA Rothm
SUBCLASS FUNARIIDAE Ochyra
Order Funariales
Family Funariaceae Schwägr.
Entosthodon attenuatus (Dicks.) Bryhn
Entosthodon fasicularis (Hedw.) C. Muell.
Funaria hygrometrica Hedw.
SUBCLASS DICRANIDAE Doweld
Order Dicranales H. Philib. ex M. Fleisch.:
Family Rhabdoweisiaceae Limpr.
Rhabdoweisia fugax (Hedw.) Bruch.& Schimp
Order Pottiales M. Fleisch.
iii- Family Pottiaceae Schimp.
Anoectangium aestivum (Hedw.) Mitt.
Barbula unguiculata Hedw.
Barbula sp.
Didymodon fallax (Hedw.) Zand. False beard- moss
Didymodon tophaceous (Brid.) Lisa

	Gymnostomum aeruginosum Sm.
	Gymnostomum calcareum Nees et Hornsch
	Microbryum davalliana (Sm.) R. H. Zander smallest pottia
SUBCLASS BRYIDAE Engl.	
4- **Order Splachnales Ochyra**	
iv- Family Meesiaceae Schimp.	
	Leptobryum pyriforme (Hedw.) Wilson
Order Bryales Limpr.:	
v- Family Bryaceae Schwägr.	
	Bryum argentum Hedw.
	Bryum alpinum
	Bryum caespiticum Hedw.
	Bryum funkii Schwäger.
	Bryum muehlenbeckii Bruch & Schimp.,
	Bryum sp.

It is clear, from (Table 2), that the identified species belong, only, to Division Bryophyta (the true mosses) which included one class, 3 subclasses, 5 orders, 5 families, 11 genera and 19 spp. The single class is Bryopsida, this result was previously expected since it has been reached by [8] and confirmed by [9] for the moss flora of the country. Each order was represented, only, by one family. Concerning families, the largest one was Potttiaceae, represented by 5 genera, and in the second order came family Funariaceae, represented by 2 genera. It's a reasonable result since family pottiaceae, on a global scale, form the most numerous moss family known containing nearly 1500 species or more than 10% of the moss species known Buck & Goffinet [10], more over [11] stated, in his revision of the family, that The total number of recognized taxa in the Pottiaceae now includes 76 genera, In national scale, Pottiaceae also form the largest moss family in Iraqi it includes 24 genera, followed by Hypnaceae which includes 13 genera [12]. All species of Pottiaceae are characteristic of variable or harsh environments, and may form a conspicuous portion of the vegetation of ruderal, arid land, alpine or arctic areas [11]. It is clear, also, from (Table 2), that the largest genus was Brym which was represented by 6 spp. while 40% of the genera represented by two species and 50% represented by one species.

3.1. Richness with species:

Richness of the nurseries with moss species were widely varied (Table 3). For example, in the most richest nurse 11 species were found while in the poorest nurse only one species was found, variations in areas, number of pots and type of seedlings between the studied nurseries located behind this wide variations

Table 3. Richness of nurseries in moss species

Names of Nurseries	Richness in species
University of Mosul, Department of Forestry	11 spp.
Ninawa, Municipality of Mosul city	9 spp.
Artdh Al-Noor	1 sp.
Al-Sahm Al-Akhdar	7 spp.
Al-Ferdaws	1 sp.
Al-Muhannad	2 spp.
Al-Muthanna	6 spp.

The results revealed that the Distribution or occurrence of the recorded species in the 7 nurseries was varied (Table 4). Some of them, as *Funaria attenuate* and *Microbryum davallianum*, occurred only in one nursery, and the other species, either occurred in two nurseries as *Bryum funkii & Bryum alpinum* or five nurseries as *Leptobryum pyriforme.* Referring to the published works about Iraqi mosses, as [8, 12, 13, 14, and 15] it was found that three species (i.e) *Bryum muehlenbeckii*, *Entosthodon fasicularis* and *Leptobryum pyriforme* were not recorded in Iraq up to date, hence the present contribution is regarded as the first record, for these species, in Iraq. Out of 7 surveyed nurseries, *B. muehlenbeckii* collected from one nursery, *E. fasicularis* from tow nurseries while *L. pyriforme* collected from five nurseries (Table 4).

Table 4. distribution of Taxa in the nurseries

	Names of the species	Names of the nurseries						
		Dept. of forestry	Ninawa	Ardh Al-Noor	Al-Sahm Al-Akhdar	Al-Ferdaws	Al-Muhannad	Al-Muthanna
1-	*Anoectangium aestivum*	●	●					
2-	*Barbula* sp.	●						
3-	*Barbula unguiculata*	●	●					●
4-	*Bryum* sp				●			
5-	*Bryum argenuum*				●			●
6-	*Bryum alpinum*		●					
7-	*Bryum caespiticium*	●	●		●			
8-	*Bryum funckii*							●
9-	*Bryum muehlenbeckii*						●	
10-	*Didymodon fallax*	●	●					
11-	*Didymodon tophaceus*	●						
12-	*Entosthodon fascicularis*		●					●
13-	*Funaria hygrometrica*	●	●	●	●	●		
14-	*Funaria attenuata*				●			
15-	*Gymnostomum aeruginosum*							●
16-	*Gymnostomum calcareum*	●	●		●			
17-	*Leptobryum pyriforme*	●	●		●		●	●
18-	*Microbryum davallianum*	●						
19-	*Rhabdoweisia fugax*	●						

3.2 Description of the species:

i- *Bryum muehlenbeckii* Bruch & Schimp.,1846: (Figure 1 and Figure 2)

Common name: Muehlenbeck's Thread-moss

Acrocarpous moss, small to medium-sized, growing in loose to crowded turfs, not forming cushion, green entirely, without red tints, not glossy. stem 3 mm height, rarely branched; rhizoids few or many, without metallic sheen, older stem sometimes densely radiculose, Leaves imbricate when dry, erecto-patent to patent when wet, green in color, ovate-lanceolate to ovate, distinctly concave, leaves length ranged between 1.0-1.5 mm and the width between 0.4-0,5 mm, leaf apex obtuse to broadly acute, apiculate; margins plain, unistratose, smooth to finely serrulate near apex; nerve ending in or below apex; alar cells not differentiated from neighbor cells, margins with one row of longer and slender cells but not forming distinct border, basal cells quadrate with scattered short rectangular cells, medial cells hexagonal, (15x100 um), upper cells also hexagonal, (20 um x 38-62 um); produce ± spherical gemmae on rhizoids, sometimes gemma carried on tomentum on older part of stem, dimension ranged between (100-175 um); the specimen without capsule.

ii- Entosthodon fasicularis (Hedwig) Muller Hal.,Syn. Musc. Frond. 1:120. 1848, Its common name is " the banded cord-moss" (Figure 3 and Figure 4)

The common name of the species is the banded cord-moss It is a small mosses, gametophyte 4 mm tall, pale green to yellow-green; mature leaves crowded at the top of the stem, l.eaves are inwardly contorted when dry erect-spreading when moist; oblong-lanceolate to ovate-lanceolate, acuminate to acute, oblong to obovate, length reach 3 mm, and the maximum width reach 0.75 mm.; leaf margin plane below and often weakly toothed (serrulate) above by projecting ends of thin-walled cells; basal leaf cells are elongate-rectangular, at leaf wings there are group of inflated cells forming auricles, upper leaf cells are rectangular and smooth, length ranged from (40-85) µm and width from (20-30) µm, basal cells dimensions ranged between (100-150) µm and (40-50) um, marginal cells somewhat longer and narrower than the adjacent medial cells; midrib (costa) ending in a subula in the upper mature leaves. The sporophytes formed frequently; capsule erect, large, smooth, globose-pyriforme when moist and sulcate when dry, have a distinct narrow neck, operculum (lid) convex, calyptra with long-beak, cuculate (split near the base); peristome teeth absent or short irregularly pointed; spores are papillose or rough (bacculate-insulate), range in size from 35-37 µm, seta straight, 7 mm long.

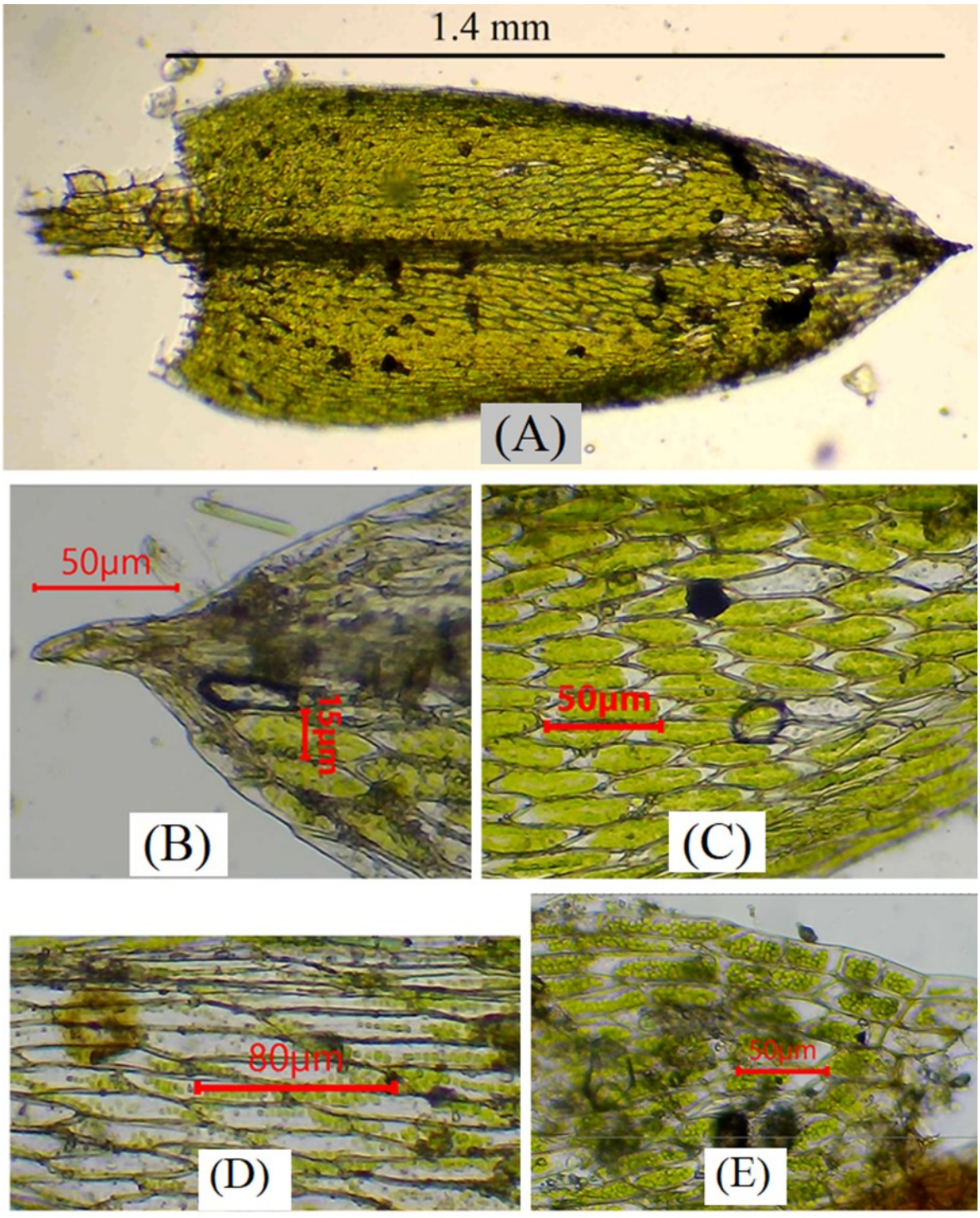

Figure (1, a-e)): *B. muehlenbeckii*: (a) leaf, (b) leaf apex, (c) upper cells, (d) median cells (e) basal cells

ii- *Leptobryum pyriforme* (Hedw.) Wilson Bryol. Brit. 219 (1855). Its common name is "Golden thread-moss" (Figure 5 and Figure 6)

Plant slender, soft, elongate, about (3-4) mm high, green to pale green in color, in loose tuft, stem un-branched, beset at extreme bases, surrounded, at extreme base, by finely papillose, red-brown rhizoid; Leaves larger and crowded in an apical coma, length ranged between (1.2–1.5) mm, and the maximum width ranged between (0.25-0.33) µm, flexuous when dry, erect to wide-spreading when moist, lanceolate proximally, abruptly long-linear distally; not decurrent at base; margins entire or sometimes denticulate near apex; apex narrowly acuminate; costae strong, broad, occupied almost 1/3 of the lamina, ending in apex; cells smooth, linear, upper cells rectangular, width 7 µm and length may reach 85 µm, some cells in the lower half of the lamina may reach 135 µm in length, basal cells irregularly quadrate or rectangular, cells dimensions at extreme base (12 x 30-40) µm and in the lower third of the lamina length of the cells may exceeded 100 µm, alar cells not differentiated. The specimens contain no capsule.

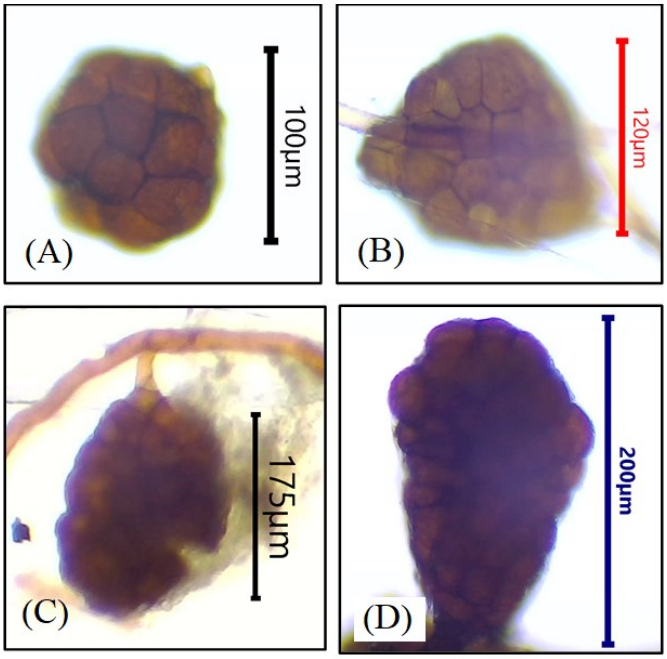

Figure (2, a-d): *B. muehlenbeckii*: Different shapes and sizes of rhizoidal gemmae

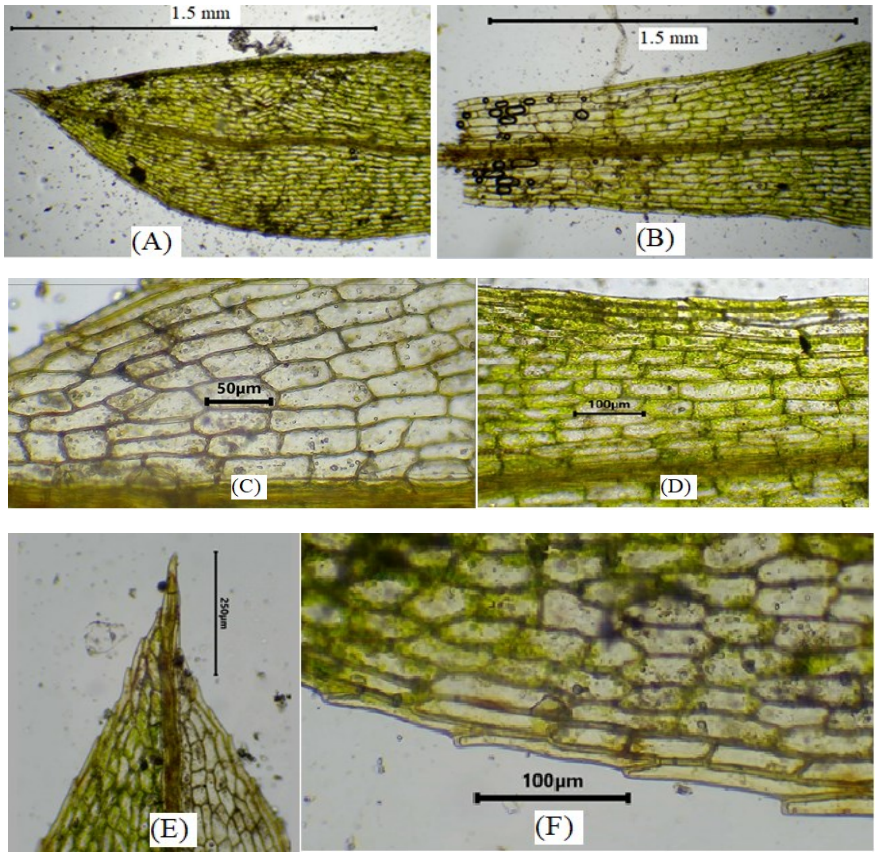

Figure (3, a-f): *Entosthodon fasicularis* leaf: (a) upper half of the leaf, (b) lower half, (c) upper cells, (d) lower cells, (e) leaf apex, (f) marginal cells

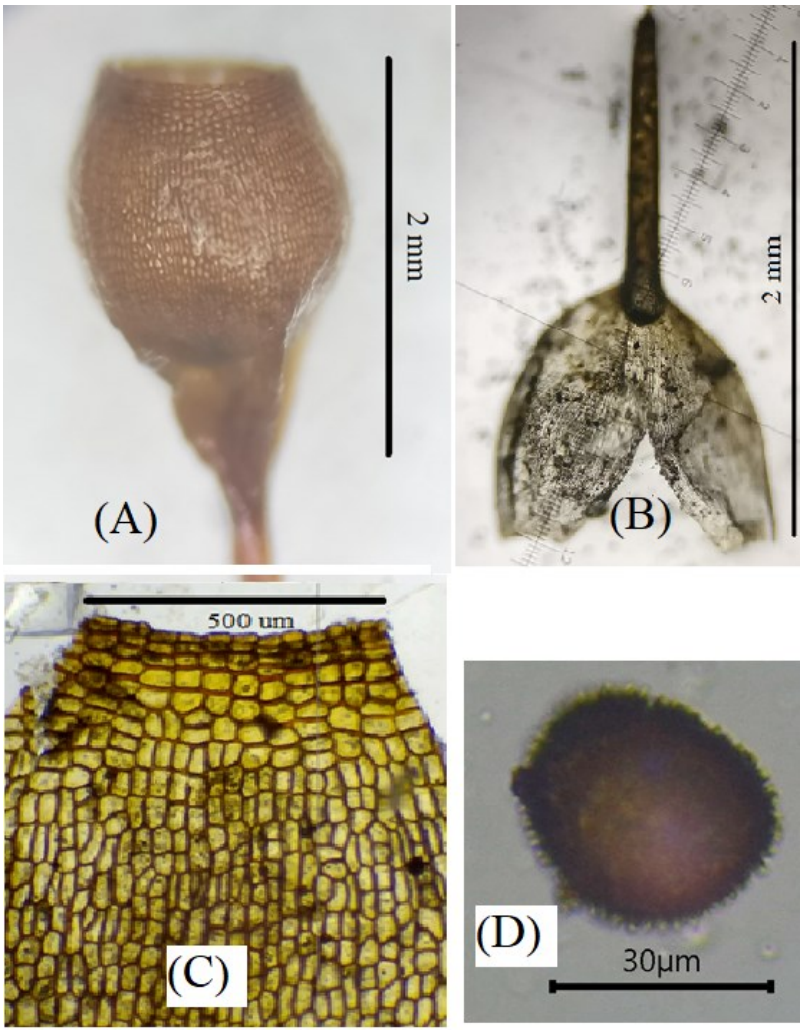

Figure (4, a-d). *E. Fasicularis*: Capsule parts ; (a) capsule, (b) calyptra, (c) capsule wall, (d) spore

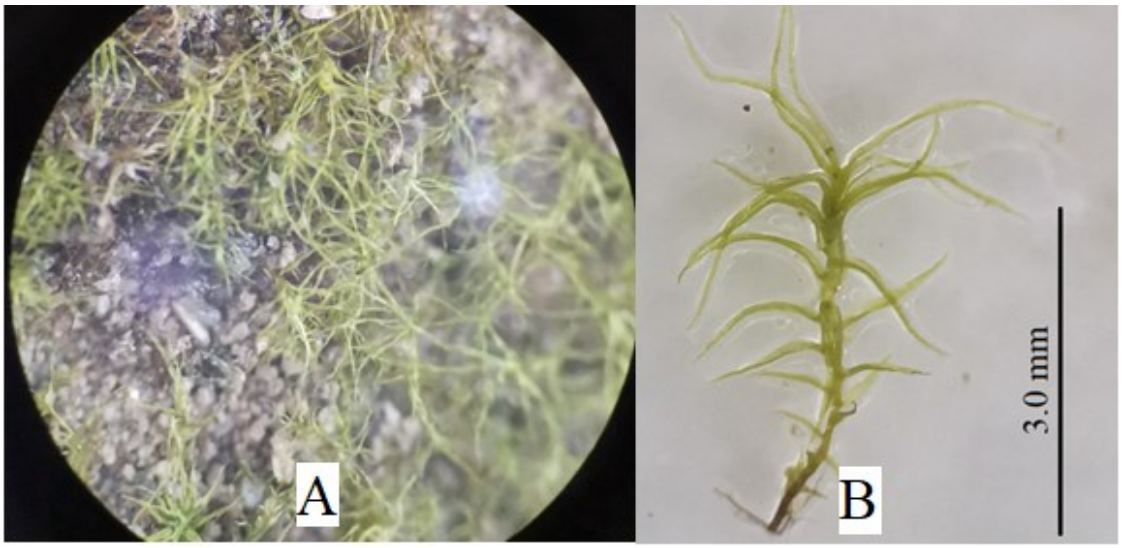

Figure (5, a &b). *L. pyriforme*: (a) loose tuft, (b) single gametophyte

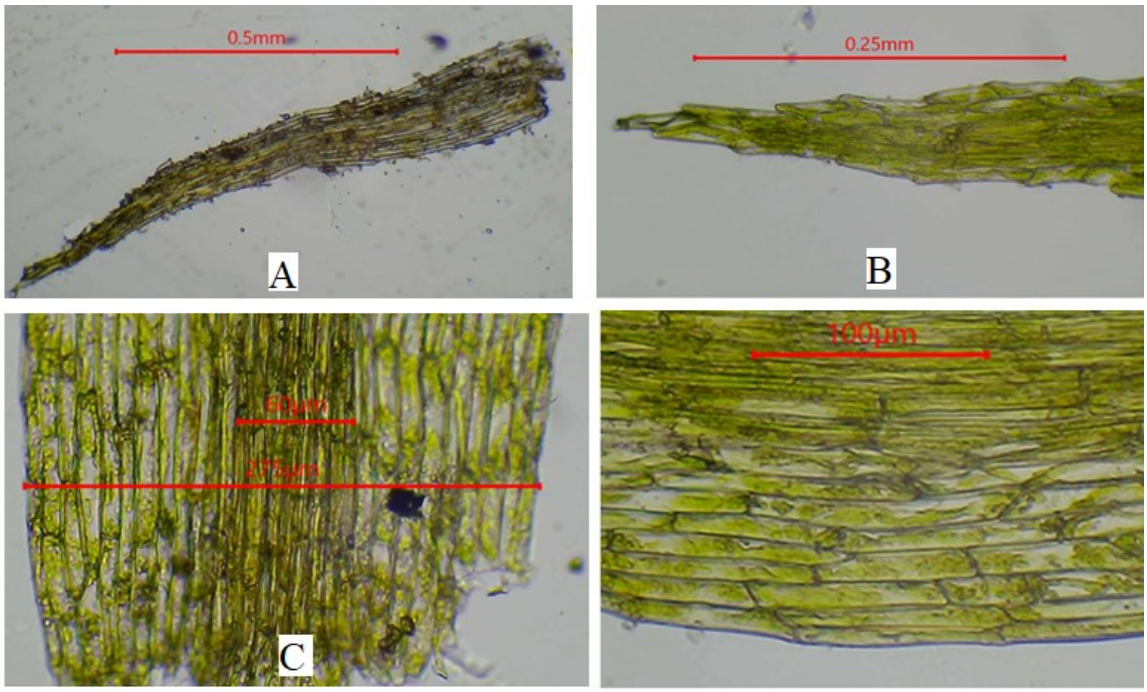

Figure (6, a-c). *L. pyriforme*: (a) leaf, (b) leaf apex, (c) basal cells and nerve, (d) upper leaf cells

4. CONCLUSION

Since that, none of the bryologist paid attention to the artificial ecosystems, up to date; the nurseries were chosen to conduct the present research to fill part of the gap in the available information about Iraqi bryoflora. The survey included 7 nurseries located in Mosul city center. Results of identification indicated presence of 11 genera and 19 species of true mosses among which the following three species: *Bryum muehlenbecki*i, *Entosthodon fasicularis* and *Leptobryum pyriforme* were considered new record for Iraq. Volume of genera and richness of the nurseries with species were widely varied, also distribution of the identified species in the nurseries was heterogeneous. It is highly recommended to achieve series of surveys for bryophytes of manmade ecosystems side by side with the natural ecosystems.

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Conflict of interest

"Basheer Ali Al-Ni'ma declares no conflicts of interest" or "We have no conflicts of interest to disclose".

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